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Fruit Recognition and its Calorie Measurement: An Image Processing Approach

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Abstract: ***Fruits contribute to an essential part of our diet because they are a major source of energy, vitamins, fiber, plant chemicals and nutrients. Fruits are naturally low in fat, sodium & calories and rich in potassium and fiber, vitamin C. A diet high in fruit can help us against cancer, diabetes, heart diseases etc. A system that gives quickly how much calories present in their diet or fruit intake that can be very useful to maintain health without expert dietitian advice. Use of image processing technique is increasing day by day in all fields and including the agriculture, food science etc. Shape, color and texture are the image features which help in classification and calorie estimation of fruits. This paper proposes an algorithm for fruit recognition and its calorie measurement based on the shape, color and texture along with histogram of gradients and GLCM with local binary pattern algorithms for texture segmentation scheme recognizing the fruits and area, major axis , minor axis are calculated by using shape feature to get more accurate calorie value. With the help of nutritional look up table these features are fed to multi SVM classifier for accurate classification. Evaluation is performed in MATLAB software using two database namely real time database and fake plastic fruit database. Results obtained are very close to real calories of the fruit.***

Keywords: Gray level co-occurrence matrix (GLCM), Histogram of oriented gradients (HOG), Local binary pattern (LBP), Multi-class support vector machine (SVM), Matrix laboratory (MATLAB).

1. Introduction

Fruits are a major source of energy, vitamins, fiber, plant chemicals and nutrients. They contribute to an essential part of our diet. Fruits are naturally low in fat, sodium & calories and rich in potassium and fiber, vitamin C. A diet high in fruit can help us against cancer, diabetes, heart diseases etc. Along with health benefits, eating fruits can make weight management easier, according to centers of disease control and prevention (CDCP) [1]. Most produce is in low calories compared to other food. So filling up on these fruit can aid in weight loss or health management. If we put a sample fruit or a plate of fruit in front of human being then he/she will unable to predict the exact or near about calorie count by just observing at it or even inspecting it by hand, because it is impossible to know the exact amount of calories so to overcome this problem we proposed this system. Researcher has combined different features like color and texture together in order to recognize fruit more accurately [2].

In this paper we propose fruit recognition and its calorie measurement system based on mobile phone or laptop device equipped with a camera. Using image segmentation methods, the fruit portion area with other geometrical parameters and texture features will be extracted from the fruit image. After that, the multi class support vector machine (SVM) technique will classify and identify the type of fruit. This will allow the system to extract the features in an exclusive approach that will give the ability to calculate the calorie of the fruit with the help of nutrient fact table from USDA national nutrient database [3].

The paper is organized in various sections. Section 2 presents related work, section 3 shows proposed system, section 4 illustrates experimental tools and results, section 5 presents performance analysis of proposed system and section 6 gives Conclusions.

2. Related Work

The aim of this section is to provide the pros and cons of existing methods and the needs for alternative approaches. We have categorized the literature survey into two ways. The work related to fruit recognition and food calorie measurment is embedded into one that illustrates the result of the proposed system. Bhanu Pratap et.al, proposed ANN based method of fruit recognition with the help of image processing technique. They propose an algorithm for fruit classification based on the shape, color and texture features. Several mathematical statistics can be calculate for each feature and give to artificial neural network (ANN) for classification. MATLAB/ SIMULINK software is used to obtain result [4]. Woo Chaw Seng and Seyed Hadi Mirisaee developed a new fruit recognition system, which combines features like size, color and shape. With the help of nearest neighbours classification method fruit images have classified and recognizeand show fruit name and user description [5].

Parisa Pouladzadeh et.al, proposed calorie measuring system that illustrates health related problems faced by human being and to reduce such problems they introduced a system that can measure calories and nutrition in every day meals and this system can help patients and dieticians to measure and manage daily food intake. Via a special calibration card technique, the algorithm gives accurate results [6]. Kavitha S. and Pavithra S. proposed an approach depends on self-adaptive resource

allocation network (SARAN). They propose a food calorie measurement method that employed to identify if the food image is good or rotten. Then, based on the body mass index (BMI) of a person, the result alarms about whether the food under analysis is suitable to the person or not. The proposed system can be useful for fitness training institutes [7].

To build our system, we will take advantage of the existing methods and overcome all their drawbacks. Proposed fruit recognition and calorie measurement system aims to use personal computer or cell phone technology to allow the user to take a picture of the selected fruit at any time and any place to measure calorie value from the captured photo. This unique method will provide more accurate results than other methods.

3. Proposed System

The proposed fruit recognition and calorie measurement system consists of two stages: recognition and second is calorie measurement. The block diagram of proposed system (figure 1) gives an idea of system. In the following section we will discuss more about image aquisition, pre-processing, segmentation and classification steps.

3.1 Image Pre-processing

Five categories of fruit images are captured using Samsung grand prime mobile phone and the images acquired were 3264 x 1836 pixels in size. Few sample databases of fruit images have been collected from fruit market of Nanded, Aurangabad (Maharashtra). No special camera set up is required to capture pictures because system will produce output of any picture taken without consideration of special set-up.

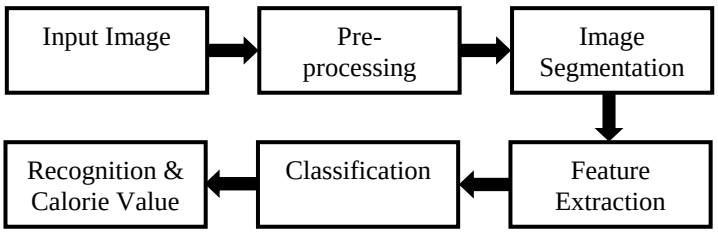

Figure 1: Block diagram of system

Pre-processing steps such as rgb to gray conversion, filtering, resizing to 256 x 256, adaptive histogram equilization is carried out. The histogram of oriented gradients (HOG) is a feature descriptor used for the purpose of object detection. In proposed system object is fruit and we proposed algorithm to recognize the fruit by combining local binary pattern (LBP) method with histogram of oriented gradients. The standered nutrient table 1 is given below which is used as reference standared database used for calorie count.

Table 1: Standard nutrient table

Fruit Name	Weight (g)	Energy (Kcal)	Protein (g)	Carbohydrate (g)
Apple	138	72	N/A	19
Orange	131	62	1	15
Banana	100	89	1	22
Mango	100	60	N/A	15
Lemon	100	47	2	16
Peach	98	38	1	9

3.2 Feature Extraction

For obtaining the accurate features we have to use appropriate segmentation scheme. This section consists of three features namely shape, color, and texture. For shape based feature extraction the geometrical region parameters like area, major axis and minor axis are calculated. For color based segmentation the HSV histogram is used. It describes colours in terms of their shades and brightness. It gives high accuracy and suitable for real time application. The mean (μ) and standard deviation (σ) is calculated by using equation 1, 2 and considered while system evaluation.

$$\sigma = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(X_i - \mu)^2} \quad (1)$$

$$\mu = \frac{1}{N}\sum_{i=0}^{N-1} X_i \quad (2)$$

The texture feature plays important role in recognition phase. Texture is calculated by objects physical properties. The texture feature helps in surface determination and shape determination. The gray level co-occurrence matrix (GLCM) is used to calculate different texture features. There are three steps to be followed for gray level co-occurrence matrix execution i.e. creating GLCM, specifying the offsets, and deriving statistics from a GLCM. The values of contrast, correlation and energy are considered and are fed to feature vector.

Classification with the multi class support vector machine (SVM) has been done. The extracted features previously mentioned will be fed to the multi class SVM classifier so that the classifier returns the fruit name and its calorie value as its output. For each feature, there will be training and testing phase. The aim of using the multi class SVM is that based on predicted value of data cases in testing set more than one classification cases are executed with increase accuracy and reduce misclassification. The first set consists of two texture features, the second set consists of two colour features, and the third set consists of three shape features. All the features of each fruit item are extracted during the segmentation phase. At the same time, it will be used as training vectors and stored database for the multi class SVM [8].

3.3 Calorie Measurement

The objective of the proposed system is to estimate the amount of calories and identify the fruit from the input allotted image. Already saved Nutrients fact table can aid for estimating correct calorie category. The system initiates to calculate the calories by comparing the inputs from the feature vector with the inputs from the nutrient tables (mass measured in gram and calorie in calories or kilo calories). To ensure the robustness of the system we have considered a genuine apple and a fake lemon for demonstrating the calorie measurements, figure 2, 3.

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4. Experimental Tools and Results

For successful execution of project the experimental tools play important role. Without any software or hardware technicalities cannot analyse the data or we cannot build the prototype. The table 2 summarizes the system requirements with database information.

Table 2: System requirements

Parameter	Description
Tools	Samsung grand prime phone, HP laptop, MATLAB\R2012a, Weighing machine, USB cable
Camera Specifications	Primary camera 5 megapixel (MP), autofocus, LED flash and Display resolution 540 x 960 pixels
Environment	Sufficient daylight
Database	125 images with 25 each
Real Fruit Classes	5 fruits (Apple, Banana, Sapodilla, Lemon and Mango)
Plastic Fruits	5 fake classes (Red Apple, Banana, Green Apple, Lemon and Ball)

4.1 Results of Genuine Fruit

The system produces output for real fruit images as well as fake fruit images. We have trained some real fruit images and some images are tested through multi support vector machine classifier. First image goes through pre-processing operations and then fed to segmentation phase which extract the feature values and gives to classifier to produce the desired result.

4.2 Results of Fake Plastic Fruit

The fake fruits i.e., are made up of plastic materials look like same as real fruit. So to increase robustness of our system we fed the fake images to the system. By naked eyes the plastic fruits are same but the texture is not same so we use the texture feature to differentiate real and fake one.

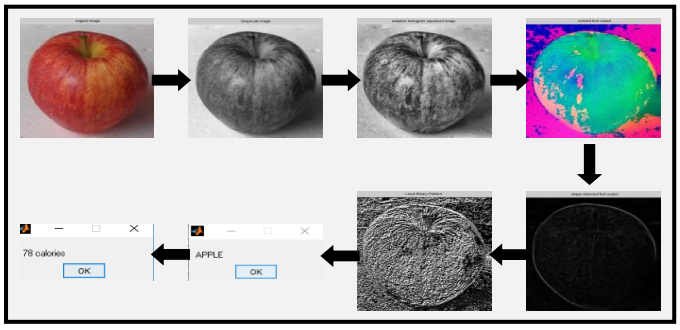

Figure 2: Results of an Apple fruit

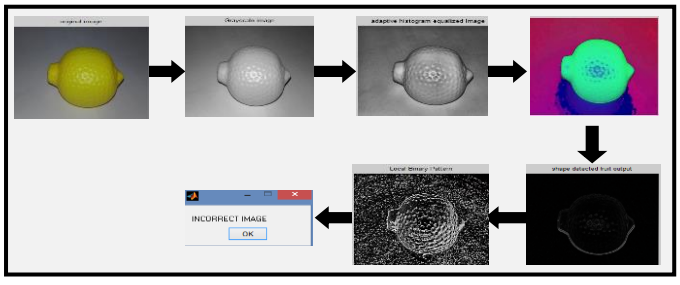

Figure 3: Results of a plastic Lemon fruit

5. Performance Analysis

The aim of this section is to analyse and evaluate the results from our experiments. Our experiments show that the accuracy level varied from one type of fruit to another. Based on this, the accuracy results can be divided into the outcomes we extracted from our measuring method. The tables and graphs of experiments performed are shown for each recognition rate and accuracy level.

5.1 Recognition Rate (RR)

For the best recognition system, recognition accuracy should be high. It is calculated as ratio of number of correctly recognized fruit samples upon total number of samples used in testing. The performance for the system is evaluated using five categories of fruit whose samples are not in data base. The samples are tested with our system. The result of recognition rate is calculated with the help of equation 3 and the correctly recognised samples and the samples which are not recognised are shown by values in the table 3 and the graph is shown by figure 4.

$$RR = \frac{\text{No. of Correctly Recognized Fruit Samples}}{\text{Total No. of Fruit Samples}} * 100 \qquad (3)$$

Table 3: Recognition Rate

Sr. No.	Fruit Name	Total Samples	No. of Fruit Recognized	Not Recognized	RR (%)
1	Banana	25	24	1	96
2	Apple	25	24	1	96
3	Mango	25	17	8	68
4	Sapodilla	25	18	7	72
5	Lemon	25	19	6	76
6	Plastic Apple	2	1	1	50
7	Ball	1	1	0	100
8	Plastic Lemon	2	2	0	100

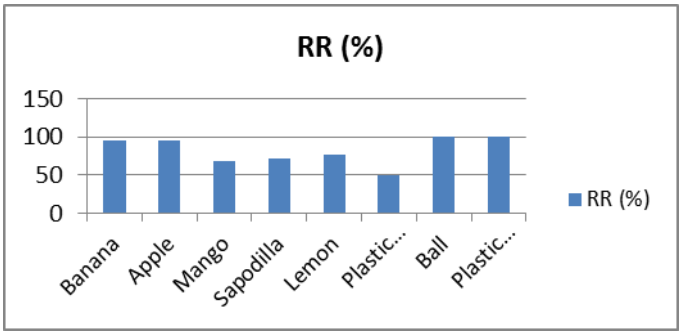

Figure 4: Recognition Rate

5.2 Accuracy of Calorie Measurement

The accuracy of calorie value is calculated by using the equation 4. Figure 6 shows accuracy graph of lemon. We have calculated individual accuracy of fruit and averaged value is considered. We calculated the average accuracy of mango, apple, sapodilla, lemon and banana shown in table 4. The graph of average accuracy of database is shown by figure 5. The accuracy of calorie measurement is calculated as ratio of measured calories to the actual calories and is given by the

following formula,

$$\text{Accuracy} = \frac{\text{Measured Calories}}{\text{Actual Calories}} * 100 \quad (4)$$

Table 4: Average accuracy of fruits calorie measurement

Sr. No.	Fruit Name	Average Accuracy %
1	Apple	99.18
2	Banana	97
3	Sapodilla	92
4	Mango	98
5	Lemon	88.72

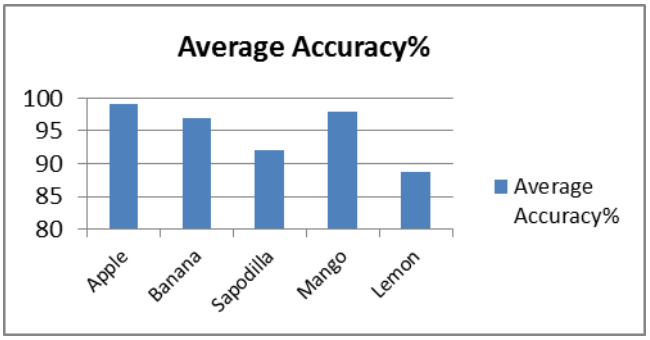

Figure 5: Average accuracy of fruits calorie

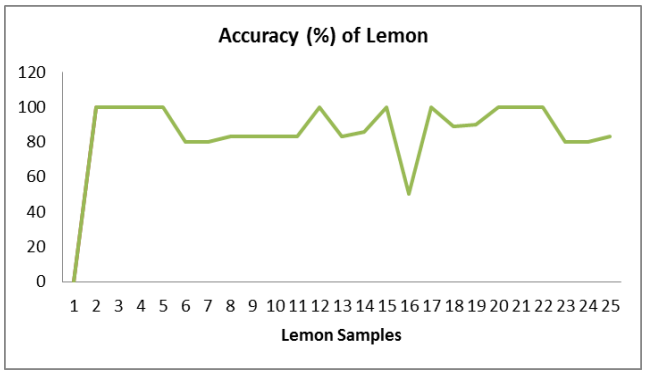

Figure 6: Accuracy of calorie values of lemon

6. Conclusions

The need to have a system that measures daily fruit intake for healthy diet is crucial due to the insufficient knowledge of diet and calorie requirements. In addition, correct fruit recognition is considered challenge. Hence, we proposed a measurement method to estimate the amount of calories from five fruit images by measuring the features of the fruit portions from the image. To reach our goal, we used phone camera or web cam. The designed sytem is robustness in nature, execution time is approximately 35 seconds as compared to other designed systems by the researchers. The system has ease of use to the user as it have the facility of automatic and manual measurement method. Accuracy of the system is up to the mark. We have successfully implemented a robust system for the correct identification of the fruit, now in future researchers can further work upon various dieseases that occur in fruits, also can determine raw, rippen and rotten fruit category, that will differentiate the value of calorie. Unhealthy fruits at the end is hazardeous for our life.

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